Characterization of Radioactive Contamination Inside Pipes with the Pipe Explorer™ System

Developer: Science & Engineering Associates, Inc.
Contract Number: DE-AC21-93MC30172
Crosscutting Area: CMST

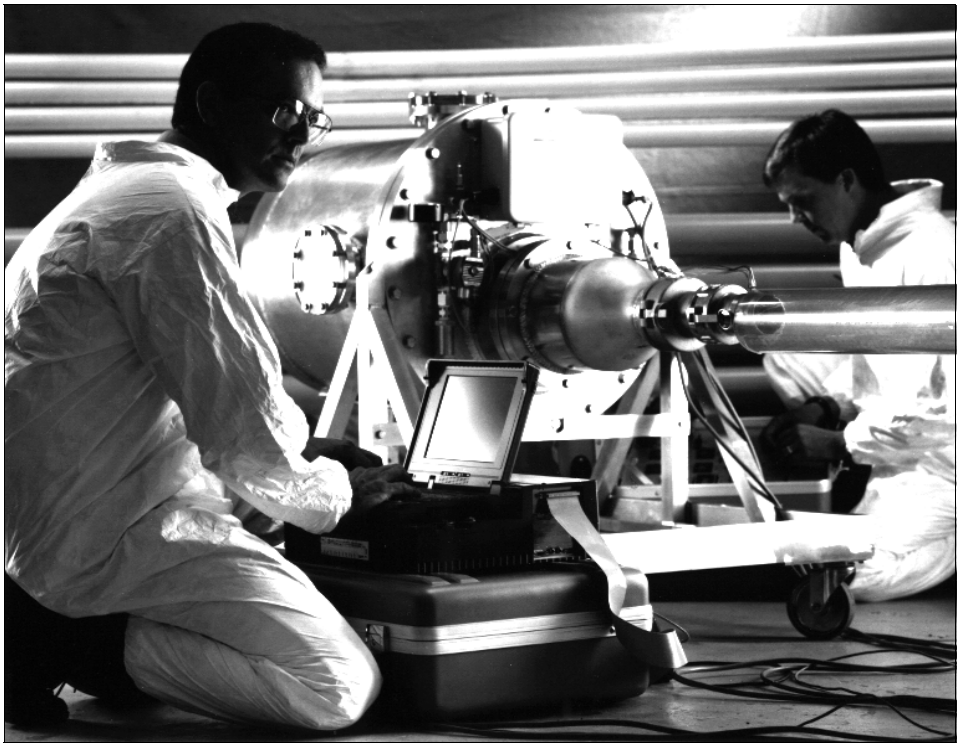
Deactivation & Decommissioning FOCUS AREA

Problem:

Radiological surveys of pipes are normally accomplished by passing a hand-held radiological sampling instrument over the exterior surface of a pipe. For a complete survey, this requires personnel to gain access to the entire exterior surface of the pipe over its full length. Access is frequently restricted and the process is difficult, time consuming, potentially hazardous, and not readily capable of detecting threshold surface contamination values.

Solution:

Development and demonstration of a remotely operated survey system (Pipe Explorer™) that integrates gamma, beta, and alpha radiation detectors and video cameras with an inverting membrane deployment system to thoroughly survey radiological contamination of pipes from the inside. The inverting membrane protects sensors from direct contact with moisture and contaminants in the pipe. This technology can transport detectors around pipe elbows and through constrictions. Radiation detectors and video cameras have been deployed through pipes ranging from 2 to 18 inches in diameter with multiple 90-degree elbows.



Benefits:

- Rapid, accurate radiological data over entire pipe length (up to 500 feet)
- Survey of locations inaccessible with existing technology
- Reduced personnel exposure, time, and costs for pipe radiological characterization
- No cross contamination of data

Technology:

Using a technique applied to borehole instrumentation emplacements (SEAMIST™), the Pipe Explorer™ system integrates standard radiation detectors with a unique inverting membrane deployment method. The deployment method utilizes a long, tubular membrane to tow instruments through the pipes.

The membrane is initially rolled up on a reel inside of a pressure-tight canister. The membrane exits the canister at the bottom and is wrapped back on the base-pipe and

clamped. As pressurized air is introduced into the canister, the membrane inverts and distends out of the base-pipe. The membrane continues to invert until its end is completely distended. A tether attached to the end of the membrane is then reeled up to retrieve the system, in reverse fashion.

To inspect the inside of pipes for radionuclide contamination, a gamma and/or beta radiation detector is mounted at the point where the tether is attached to the membrane. As the detector traverses the pipe, pulled by the advancing membrane, electrical pulses proportional to radioactivity on the surface are transmitted through a cable back to the canister and subsequently to a data acquisition system. Pulses are either simply counted for a gross contamination scan, or analyzed with a multi-channel pulse-height analyzer to determine their energy and hence, the specific radioisotope.

The primary nuclear detectors that are used with the deployment system are sodium iodide and cesium iodide scintillation detectors coupled to photomultiplier tubes for gamma measurements. For beta measurements, an organic scintillator coupled to a photomultiplier tube was used. Since alpha particles cannot penetrate the membrane, a scintillating material is embedded into the membrane for specific alpha surveys. This scintillation is then detected by a photodiode located inside the membrane, which keeps the photodiode shielded from outside contamination. These detectors are configured in compact packages small enough to be transported around bends and obstructions in piping systems.

The detectors have been integrated with the inverting membrane deployment method so that the system can be used to inspect pipes with inside diameters 2 inches and greater. The system will be used in piping runs up to 500-ft long with and without multiple elbows and obstructions. The system control and data acquisition are remotely operable.

Project Conclusion:

The development of the Pipe Explorer™ system began in October 1993. Since that time, two complete deployment systems have been developed that incorporate 4 types of beta/gamma detectors, alpha detectors, video cameras, and pipe locators. These survey tools have been successfully used with the system at 4 Department of Energy (DOE) sites: Idaho National Engineering and Environmental Laboratory (INEEL), a Formerly Utilized Sites Remedial Action Program (FUSRAP) site in Adrian, Michigan, the Inhalation Toxicology Research Institute (ITRI), and Argonne National Laboratory (ANL).

In addition, the system has been used to conduct radiation and video surveys at the Mound and Grand Junction Projects Office (GJPO) facilities under firm fixed price and performance based contracts.

Through these uses of the system, the DOE has saved over $3 million by avoiding the cost of excavating and disposing of buried and encased pipes that could be left in place.

The development of the Pipe Explorer™ system through the FETC concluded in September 1997. Science & Engineering Associates, Inc. (SEA) is now actively marketing Pipe Explorer™ services to DOE deactivation and decommissioning (D&D) projects and commercial nuclear reactor D&D projects.

Contacts:

SEA develops, builds, fields, and commercializes radiological and chemical characterization technologies for application to DOE needs. For information on this project, the contractor contact is:

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